IOWA DEVELOPMENT OF RUBBLIZED CONCRETE PAVEMENT BASE MILLS COUNTY

Construction Report
Iowa Highway Research Board
Project HR-315

March 30, 1990

Highway Division
Iowa Department of Transportation

Construction Report
for
Iowa Highway Research Board
Research Project HR-315

Iowa Development of Rubblized Concrete Pavement Base

Vaughn Bennett
Assistant to the Engineer
712-527-4873
Mills County Secondary
Road Department
Glenwood, Iowa

March 30, 1990

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DISCLAIMER

The contents of this report reflect the views of the author and do not necessarily reflect the official views of the Iowa Department of Transportation or Mills County. This report does not constitute a standard, specification or regulation.

ABSTRACT

The concept of rubblizing existing concrete pavement prior to the placement of an asphaltic cement concrete overlay has been around for several years and, in fact, has been tried successfully in the states of New York, Michigan, and Ohio.

With available construction and maintenance dollars usually not meeting the demands of the needed work, much of the necessary rehabilitation of existing portland cement concrete pavements is not being completed when it would be most beneficial. Research project HR-315, "Iowa Development of Rubblized Concrete", has been undertaken to determine the effects of rubblized concrete pavement base as it affects the cracking pattern and longevity of the ACC overlay.

Over the past thirty years, the counties of Iowa have constructe several thousand miles of portland cement concrete pavement. The poi has been reached where these pavements have deteriorated to a conditi that they are in need of rehabilitation or reconstruction. Because o the cost of total reconstruction, several alternatives are being reviewed to rehabilitate these deteriorated pavements including standard overlays, placement of engineering fabric, rock, open graded bituminous mixes, and cracking and seating the old pavement. While these methods have prolonged the life of the roads, the cracks in the old pavement have eventually reflected to the surface of the overlay such an extent that the new road surface becomes a carbon copy of the old surface. The most successful method to date appears to be the cracking and seating operation, but research is still ongoing concerning this program with final results not yet available.

Due to budget constraints, these deteriorating PCC pavements are typically not being repaired at the most opportune time, but are rehabilitated later when a more substantial repair is then required. Since this work is not being done, many of the existing pavements hav deteriorated beyond the point where standard methods, including cracking and seating, would be most successful. If the pavement has become severely deteriorated, before the cracking and seating operati can take place, full and partial depth patching of joints, "D" cracke areas, and areas of load related pavement failure is necessary. This patching process can increase the cost of the cracking and seating procedure to a point where other alternatives, including complete replacement, should be investigated.

OBJECTIVE

This research is being conducted to develope a rehabilitation procedure for severely deteriorated pavements. A method that has been used in other states is the rubblizing of the existing portland cement concrete pavement to create a base that is very similar to a crushed stone base and then overlay it with several inches of asphaltic cement concrete. The objective of this research is to determine how the "recycling" of an existing severely deteriorated pavement, through rubblizing, to create a "stone base" will affect:

1. The thickness of overlay that can be placed on the road.
2. Whether the base will provide adequate drainage.
3. Any cracking pattern that may develop in the ACC overlay.
4. Its life.
5. Its structural integrity
6. The cost effectiveness of this procedure.

The objective of this report is to describe the construction procedures utilized and any problems that were encountered. Over the five year research period, we hope to be able to provide answers to the six objectives listed above.

PROJECT DESCRIPTION

This project is on Mills County Road L-63 (FAS route 6058) from its intersection with county road H-40, north and east approximately 1.9 miles to the south corporate limits of Malvern. This road is a 22' wide, 6" thick slipform, Class B, PCC pavement with 40' joint spacings. The pavement was constructed with Class 1 coarse aggregate and shows severe joint deterioration in the form of pop-outs, "D" line

cracked areas, and a loose pavement structure that has failed to such an extent that the pavement had shifted toward the foreslope. Load related failure in the "Y" pattern is very apparent at the outside edges of the pavement. See photographs 20-a, 20-b, 20-c. The averag daily traffic varies from 580 vpd near the south end of the project t 1190 vpd at the north end. See Exhibit "A" for the location of the project

CONSTRUCTION

The project was let on May 16, 1989 with award being made to Cessford Construction Co. from LeGrand, Iowa. The total contract amount was $286,990.30 of which $26,471.90 was for the rubblizing process. The remainder of the contract included application of choke stone, ACC pavement, full depth granular shoulders, guardrail, and other associated items. Exhibit "B" is a copy of the contract with Cessford Construction Co.

With the exception of two areas of the existing pavement that we left in their current condition and overlayed with either 3" or 5" of asphalt to serve as control sections, the entire PCC pavement was rubblized using a PB4 pavement breaker manufactured by Gurries Industries. The PB4 is a resonant pavement breaker that transmits power through a massive 6.5" x 18.0" x 12.5' long forged steel beam operating at a frequency of 44 impacts per second that transmits a force to the pavement of approximately 2000# per impact and moves at speed of approximately 2.5 miles per hour. See photographs 21-a, 21- 22-a, 22-b, 22-c. Exhibit "C" is a copy of the special provisions fo the rubblizing of this project.

After the rubblizing, a 2" to 4" layer of 3/4" choke stone was

spread over the broken concrete to act as a base leveling course, to fill voids caused by the rubblizing, and to help stabilize the rubblized base. See photographs 23-a, 23-b. This was followed by the placement of varying thicknesses of asphaltic cement concrete pavement and the installation of subdrains along the pavement edge. See photograph 24-a. The subdrains were located in such a manner so as to drain a portion of different thicknesses of the ACC pavement as well as a transition area. Exhibit "D" is a layout of the project showing the locations of the rubblized pavement, the locations of the various thicknesses of asphalt pavement, and the locations of the subdrain installations.

DAILY CONSTRUCTION RECORD

TUESDAY, SEPT. 5, 1989

The rubblizing procedure began at station 95+00 on Tuesday, Sept. 5, 1989 and proceeded south toward the B.O.P. The entire width of the pavement was rubblized rather than just one lane at a time. The contractor began with a 9" shoe on the PB4 but was not achieving a small enough particle size so he converted to a 7" shoe which provided better results. It was hoped that the PB4 would break the pavement down to a maximum particle size of approximately 2", but we found that with the sub-base conditions that existed, this would be impossible. In order for the PB4 to operate most efficiently, it must impact against a solid surface. We found that we had a soft sub-grade which caused the concrete to be broken into pieces ranging from 12" to 18". Where the sub-grade was reasonably solid, the broken concrete pieces ranged from 6" to 8". In the areas where there was severe "D" cracking, the pavement was broken down to a condition that resembled a

crushed stone with maximum sizes of 1" to 2". Approximately 2022 sq. yds. of pavement were rubblized today.

WEDNESDAY, SEPT. 6, 1989

Rubblizing continued approaching the B.O.P. Near station 81+00 sub-grade seep area was encountered which would not allow complete rubblizing of the pavement. The sub-grade was so soft that the PB4 pavement breaker fell through the broken pavement and became stuck. Additionally, while continuing to break up the old pavement in that area, the PB4 occasionally had to be pushed to prevent it from gettin stuck again. An additional 6222 sq. yds. of pavement were rubblized today.

The contractor began applying the choke stone in the afternoon with a "Jersey" spreader attached to a bulldozer. The spreader was s to place the stone at a depth of 2". After choking, some of the rubblized pavement was exposed but did not appear to present any problems during the compaction procedure but it was felt that it shou be removed before the placement of any ACC pavement. The contractor found that if he were to lightly blade the choke stone after rolling, he achieved a better grade on which to lay the asphalt pavement.

THURSDAY, SEPT. 7, 1989

We received approximately 1.5" of rain overnight which made the sub-grade to spongy to complete any work. The rain continued intermittently until approximately 11:00 o'clock a.m. With the exception of digging outlets in the shoulder of the road to allow the water to get out of the base, all activities ceased until the open house demonstration at 12:30 o'clock p.m. at which time 6 loads of choke stone were applied using the procedure described earlier and

rubblizing commenced. The rubblizing continued for the remainder of the day with approximately 8825 sq. yds. of pavement being broken up today.

An open house was held beginning at 10:30 o'clock a.m. with an informational meeting on rubblizing and alternate techniques of pavement repair with asphalt cement concrete pavement. At 12:30 the people in attendance were bused to the project site to observe the choking and rubblizing operations.

FRIDAY, SEPT. 8, 1989

We again received an extreme amount of rain overnight and all operations on the project were suspended.

Discussions during the day concerning the drainage problem resulted in a decision to attempt to install the drainage structures before the placement of the ACCP. It was felt that this would help to stabilize the sub-grade as well as prevent any damage to the ACC pavement surface.

MONDAY, SEPT. 11, 1989

Approximately 3619 sq. yds. of pavement were rubblized today. This completed the rubblizing operation with a total of 20701 sq. yds. of pavement being rubblized.

In the morning,the contractor began applying choke stone again in preparation for the placement of ACC pavement at a later date.

A second layer of choke stone was applied over the area near station 81+00 to serve as a strengthening course. The choke stone that had been applied prior to the rain had developed a crust on the surface much like that on a granular surfaced road.

TUESDAY, SEPT. 12, 1989

The placement of the ACCP was to begin this morning but rain overnight prevented this. The remainder of the choke stone was place today. Discussions on the sub-drain installation brought to light a scheduling problem so it was decided to begin ACCP placement on Wednesday, Sept. 13th without the installation of the drains. The placement of the ACCP would begin near station 64+00 and proceed towa the B.O.P. The contractor would then complete the project by startin at 64+00 and proceed to the E.O.P. This procedure would prevent load ACC trucks from driving over the 3" and 4" portions of the fresh pavement.

WEDNESDAY, SEPT. 13, 1989

The ACCP placement was to begin today but a check of the materia gradation showed that the minus 200 sieve of the coarse stone was out of specification by approximately 3.5%. Replacement material will ne to be crushed in order for the project to continue.

FRIDAY, SEPT. 15, 1989

After conferring with the IDOT District #4 materials office, it was determined that an approved combined gradation could be achieved using three aggregates in the following percentages:

out of spec. rock	= 15%
new rock	= 45%
sand	= 40%

The placement of the ACCP began as described earlier at approximately 1:15 o'clock p.m. and approximately 1000 tons of mix we placed.

MONDAY, SEPT. 18, 1989 THROUGH WEDNESDAY, SEPT. 20, 1989

The placement of ACCP continued and was completed on Wednesday. No problems out of the ordinary were encountered.

The intended base thickness was 3.5" but due to the somewhat rough sub-grade that resulted from the rubblizing, the actual thickness of the ACC pavement ranged from 3.13" to 5.00" with an average of 3.61". The densities ranged from 96.636% to 101.048% with an average density of 98.274%.

SATURDAY, SEPT. 23, 1989 THROUGH MONDAY, SEPT. 25, 1989

The placement of full depth shoulders was begun and completed on the entire length of the project.

FRIDAY, SEPT. 27, 1989 THROUGH FRIDAY, Oct. 6, 1989

The required pavement markings and construction of guardrails on the bridge at station 30+00 were completed.

WEDNESDAY, OCT. 11, 1989 THROUGH TUESDAY, OCT. 24, 1989

Work was done on the installation of shoulder drains. A problem developed in that when the trench was cut to place the drain tile, on occasion the saw would get caught on a piece of the rubblized concrete and be pulled upward and break off the edge of the ACC pavement. After looking at the soil that came out of the trench and seeing that it would allow water to percolate through it, we decided to move the drain away from the edge of the ACC pavement approximately 6" to avoid damaging the pavement. Two different trenching methods were used. Initially, a large concrete wheel saw was utilized, but it was this method that was causing the fraying of the ACCP edges as well as allowing a considerable amount of material to remain in the trench. A

"Ditch Witch" type trencher was then brought to the site to complete the operation. Using this machine, the contractor was able to have more control on the depth of the trench, was able to eliminate the fraying of the ACCP edge, and also achieve a much cleaner trench.

TUESDAY, OCT. 24, 1989

A final inspection was conducted and project approval given.

PERFORMANCE

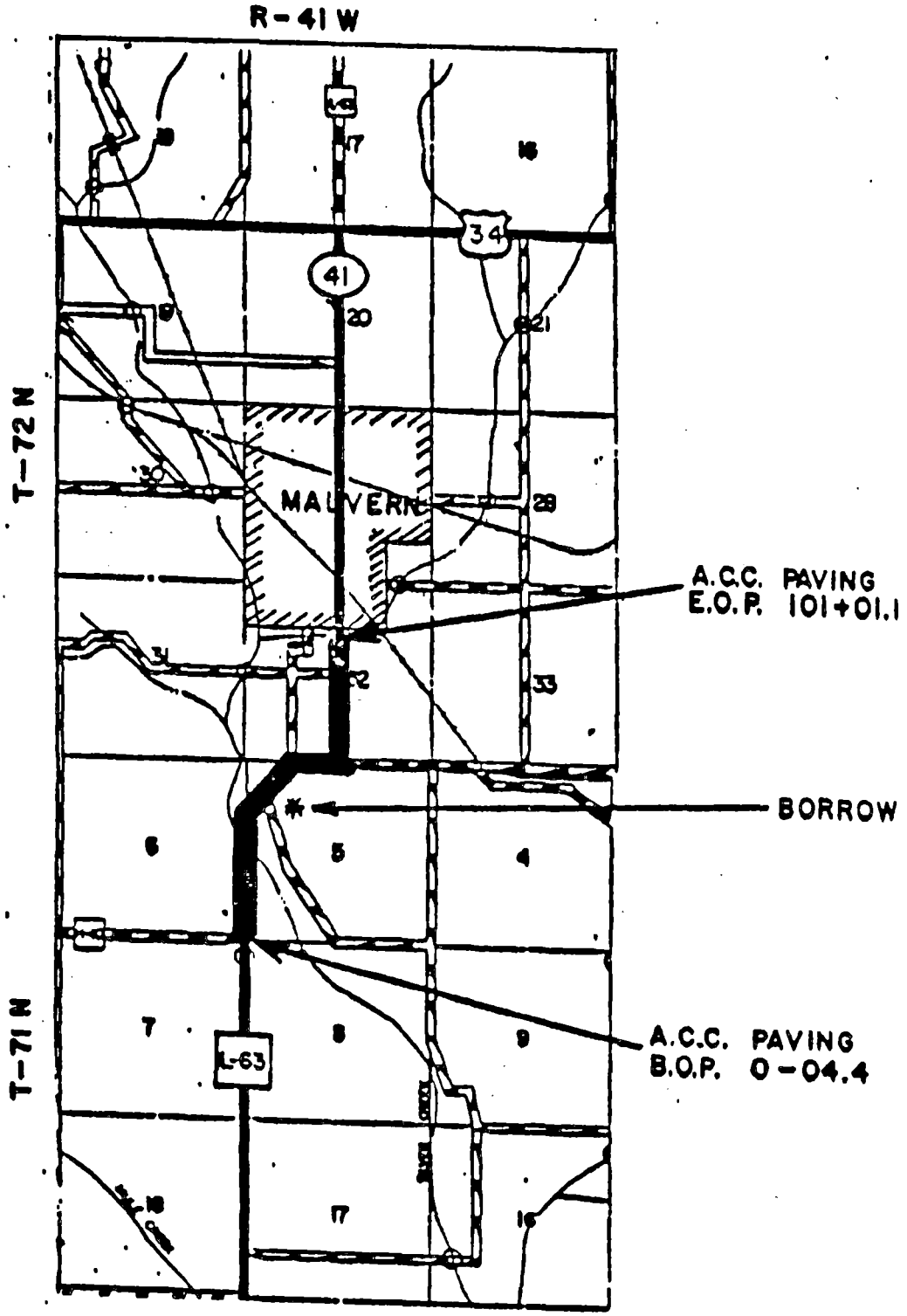
As of the writing of this report, the performance of the section of road has been very satisfactory. While there are some areas where the rideability is not the most desirable, it has improved greatly and no cracks have developed in the surface.

ACKNOWLEDGEMENTS

Research project HR-315 was sponsored by the Iowa Highway Research Board and Mills County. Funding for this project was from the Secondary Road Research Fund in the amount of $62,984.00 and the remainder from the Mills County Farm to Market Fund. Additionally, due to the experimental nature of this project, there were contingency funds reimbursable to Mills County throughout the research period of five years for costs incurred as a result of this research in the amount of $35,545.

The Mills County Secondary Road Department wishes to extend their appreciation to the Mills County Board of Supervisors, the Iowa Department of Transportation, and the Asphalt Paving Association of Iowa for their support in developing and conducting this project. Additionally, we would like to thank the employees of Cessford Construction Company for the extra effort and cooperation that was put forth in the completion of this research project.

APPENDIX



LOCATION MAP

NO SCALE

Form 650019 8-87 H-688

CONTRACT NO. 30059

County MILLS Project No. SN-6058(1)--51-65
Type of Work ASPH CEMENT CONC PAVEMENT Miles 1.9140
Cost Center 801000 Object Code 860
ON SECONDARY ROAD L63 FROM THE JUNCTION SECONDARY ROAD H40 NEAR THE NW CORNER OF SECTION 8-71-41, NORTH TO THE MALVERN CITY LIMITS.

This agreement made and entered by and between the BOARD OF SUPERVISORS OF MILLS COUNTY, IOWA

Contracting Authority, and

CESSFORD CONSTRUCTION CO. OF LE GRAND, IOWA

00007350 Contractor.

It is agreed that the notice and instructions to bidders, the proposal filed herein, the general specifications of the Iowa Department of Transportation for 1984, together with supplemental specifications and special provisions, together with the general and detailed plans, if any, for said project SN-6058(1)--51-65, together with Contractor's performance bond, are made a part hereof and together with this instrument constitute the contract. This contract contains all of the terms and conditions agreed upon by the parties hereto. A true copy of said plans and specifications is now on file in the office of the Contracting Authority under date of MAY 11, 1989.

Contractor, for and in consideration of $ ****286,990.30, payable as set forth in the specifications constituting a part of this contract, agrees to construct various items of work and/or provide various materials or supplies in accordance with the plans and specifications therefor, and in the locations designated in the Notice to Bidders.

Contractor certifies by his signature on this contract, under pain of penalties for false certification, that he has complied with Iowa Code Section 324.17(8) (1985) as amended, if applicable.

In consideration of the foregoing, Contracting Authority hereby agrees to pay the Contractor promptly and according to the requirements of the specifications the amounts set forth, subject to the conditions as set forth in the specifications.

It is further understood and agreed that the above work shall be commenced or completed in accordance with the following schedule:

START. DATE	COMPL. DATE	WORK. DAYS
	10/20/89	40

Time is the essence of this contract.

To accomplish the purpose herein expressed, Contracting Authority and Contractor have signed this and four other identical instruments as of the 1st day of June, 1989.

BOARD OF SUPERVISORS OF MILLS COUNTY, IOWA

By Rhuland L Gammon
Contracting Authority

Contracts Engineer JUN 5 1989
Date

CESSFORD CONSTRUCTION CO. OF LE GRAND, IOWA

By Stephen C Knabbe
Contractor

IOWA DEPT. OF TRANSPORTATION

Form 650031 8-87 H-686

CONTRACT PRICES

Proposal I.D. No. 890791 · CONTRACT NO. 30059 · Bid Order No. 65

Contractor's No. 0,7,3,5,0 · County MILLS · Page No. 1

Project No. SN-6058(1)--51-65 · Type of Work ASPH CEMENT CONC PAVEMENT

Line No.	Item	Item Quantity and Units	Unit Price		Amount
			Dollars X,XXX,XXX	Cents XXXX	Dollars XX,XXX,XXX
0010	RUBBLIZING PAVEMENT	20363 SQ. YDS.	1.3000		26,471.
0020	ASPHALT CEMENT CONCRETE, TYPE B SURFACE COURSE, MIXT. SIZE 1/2 IN.	5765 TONS	17.2800		99,619.
0030	ASPHALT CEMENT	339 TONS	124.8000		42,307.
0040	SUBDRAIN, (LONGITUDINAL) AS PER PLAN	7353 LINEAR FT	2.6000		19,117.
0050	SHOULDERS, GRANULAR, TYPE B	2087 TONS	10.1600		21,203.
0060	SURFACING, DRIVEWAY	405 TONS	11.0500		4,475.
0070	PAVEMENT MARKINGS, TRAFFIC STRIPE REFLECTORIZED, BROKEN LINE YELLOW	1.67 MILES	280.0000		467.
0080	PAVEMENT MARKINGS, TRAFFIC STRIPE REFLECTORIZED, SOLID LINE YELLOW	1.65 MILES	280.0000		462
0090	PAVEMENT MARKINGS, TRAFFIC STRIPE REFLECTORIZED, SOLID LINE WHITE	3.83 MILES	280.0000		1,072
0100	GUARDRAIL, END ANCHORAGES, BEAM, RE-52	4 ONLY	360.0000		1,440
0110	GUARDRAIL, END ANCHORAGES, BEAM, RE-53	1 ONLY	450.0000		450
0120	GUARDRAIL, FORMED STEEL BEAM	181.25 LINEAR FT	7.6000		1,377
0130	GUARDRAIL, FORMED STEEL THRIE BEAM	637.5 LINEAR FT	12.5000		7,968
0140	GUARDRAIL, POSTS, BEAM	53 ONLY	41.8000		2,215
0150	MOBILIZATION	LUMP SUM			14,123
0160	BRIDGE CONNECTIONS	86 ONLY	43.0000		3,698
0170	PRIMER OR TACK-COAT BITUMEN	1216 GALLONS	0.6800		826
0180	EXCAVATION, CLASS 10, ROADWAY & BORROW	1145 CUBIC YDS	3.5000		4,007
0190	PAVEMENT SCARIFICATION	255 SQ. YDS.	10.2500		2,613
0200	SEEDING, FERTILIZING & MULCHING	1.7 ACRES	2200.0000		3,740
0210	SAMPLES	LUMP SUM			250

0031 8-87 H-688

CONTRACT PRICES

I.D. No. 890791 | CONTRACT NO. 30059 | Bid Order No. 65

tor's No. 0,7,3,5,0 | County MILLS | Page No. 2

No. SN-6058(1)--51-65 | Type of Work ASPH CEMENT CONC PAVEMENT

e No.	Item	Item Quantity and Units	Unit Price Dollars X,XXX,XXX	Unit Price Cents XXXX	Amount Dollars XX,XXX,XXX	Amount Cents XX
	(CONTINUED)					
0	TRAFFIC CONTROL	LUMP SUM			2,500.00	
0	BASE, CHOKE STONE	2645 TONS		10.0500	26,582.25	
				TOTAL	$286,990.30	

LAST PAGE

Iowa Department of Transportation

SPECIAL PROVISIONS
for
RUBBLIZING EXISTING PORTLAND
CEMENT CONCRETE PAVEMENT

Project SN-6058(1)--51-65, Mills County

May 16, 1989

812.01 DESCRIPTION. Under this item, the contractor shall rubblize and compact the existing non-reinforced portland cement concrete pavement as shown on the plans or as directed by the Engineer.

812.02 MATERIALS. All choke stone material shall meet the requirements of Article 4120.04 of the 1984 Standard Specifications with a maximum particle size of 3/4".

812.03 EQUIPMENT. The equipment required for the rubblizing process shall be a self contained, self propelled, resonant frequency pavement breaking unit capable of producing low amplitude, 2000 pound force blows at a rate of not less than 44 per second. The unit shall be equipped with a water system to suppress dust generated by the operation. A standard steel drum vibratory roller having a gross weight of not less than 10 tons operated in the vibration mode shall be used to compact the rubblized pavement.

812.04 CONSTRUCTION METHODS. A transverse joint shall be sawed full depth and load transfer devices severed on the mainline where the rubblizing abuts concrete pavement which is to remain in place. The operating speed of the rubblizing unit shall be such that the existing pavement is reduced into particles with a nominal size of 2". continuous coverage with the breaking shoe shall be required. Additional passes of the resonator may be required if larger sizes remain after the initial rubblizing pass. Unless otherwise directed by the Engineer, the rubblizing procedure shall begin at a free shoulder edge and work to the longitudinal centerline joint.

Prior to placing the initial bituminous course, the rubblized pavement shall be compacted with 4 passes of a vibratory steel drum roller. The roller shall be operated at a speed not to exceed 6 feet per second. Any depressions in the compacted rubblized base of 1" or greater in depth from that of the surrounding area, shall be leveled using a 3/4", Class "A" crushed choke stone as specified on the plans. Additionally, the crushed choke stone will be used as needed to establish the final gradeline before the initial bituminous course is applied. The crushed choke stone shall then be compacted with the same roller and compactive effort previously described.

Reinforcement in the rubblized pavement shall be left in place. However, any reinforcement exposed at the surface as a result of rubblizing and/or compaction operations shall be cut off below the surface and removed from the site.

Except at restricted crossovers, traffic will not be allowed on the rubblized pavement before the initial bituminous base is in place. No more than 48 hours shall elapse between rubblizing pavement segments and placement of the initial bituminous course. In the event of rain, however, this time limitation may be extended to allow sufficient time for the rubblized pavement to dry to the satisfaction of the engineer.

812.05 METHOD OF MEASUREMENT.

A. Rubblizing Pavement. The total area of rubblized pavement shall be measured in square yards by the Engineer.

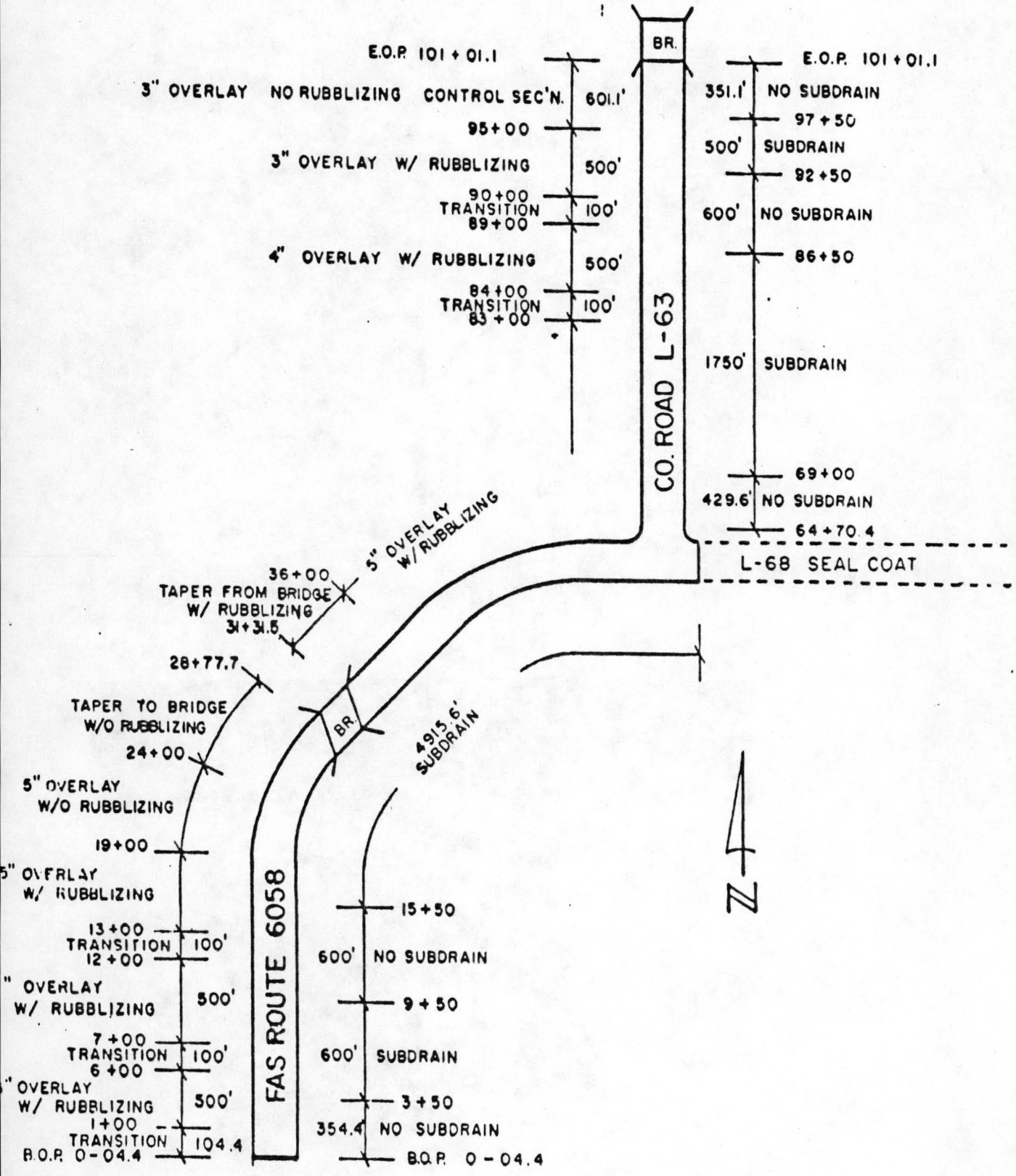
B. Choke Stone Base. The quantity of choke stone base placed shall be measured as provided in Article 2210.11 of the 1984 Iowa Department of Transportation Standard Specifications.

812.06 BASIS OF PAYMENT.

A. Rubblizing Pavement. For the number of square yards of pavement rubblized, the Contractor will be paid the contract price per square yard. This payment shall be full compensation for furnishing all equipment and materials, including water, and labor to rubblize the pavement, suppress dust, remove exposed reinforcement, and compact the rubblized pavement until the initial bituminous course is in place.

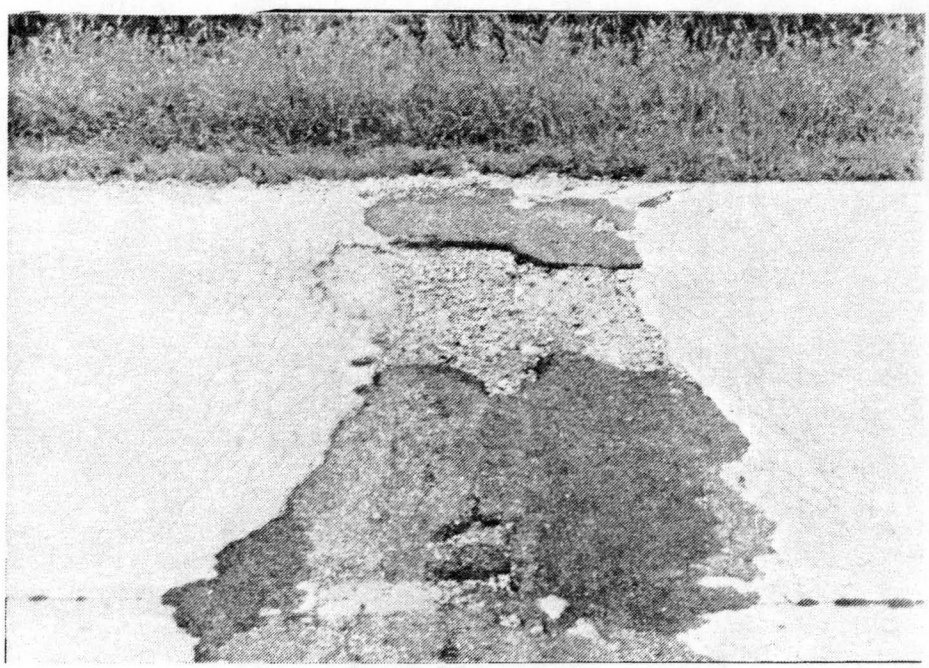
B. Choke Stone Base. For the number of tons of choke stone base placed, the Contractor will be paid as provided in Article 2210.12 of the 1984 Iowa Department of Transportation Standard Specifications.

PROJECT LAYOUT



20a - Typical Longitudinal Cracking

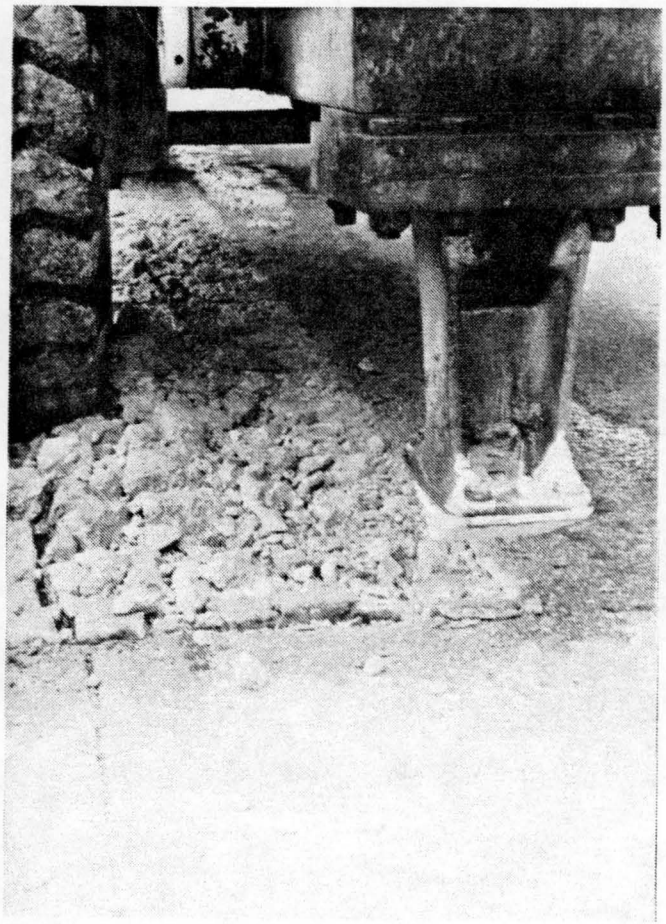
20b - Load Related Pavement Failure



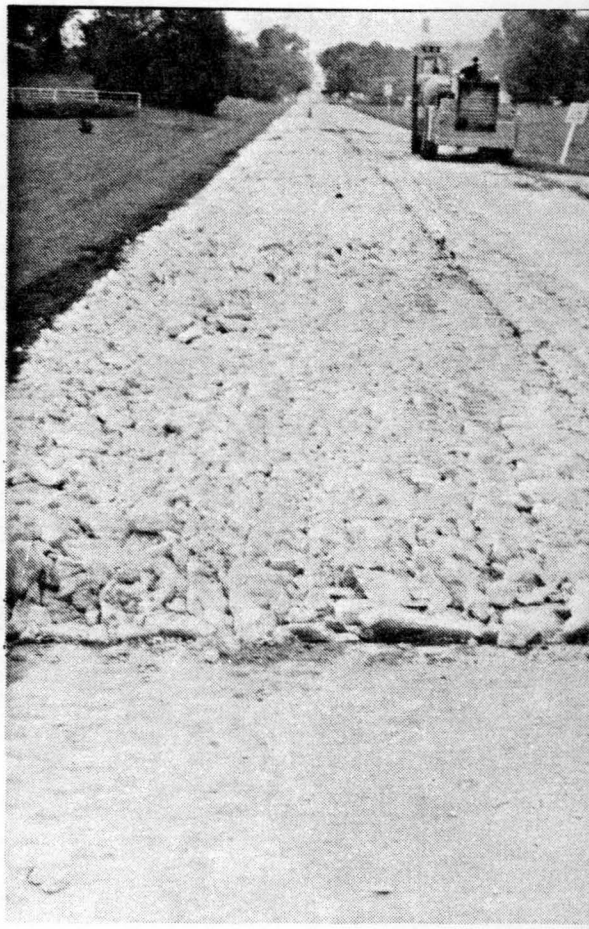
20c - Complete Joint Failure

21a - PB4 Pavement Breaker
By "Gurries, Ind."

21b - PB4 Pavement Breaker in Operation

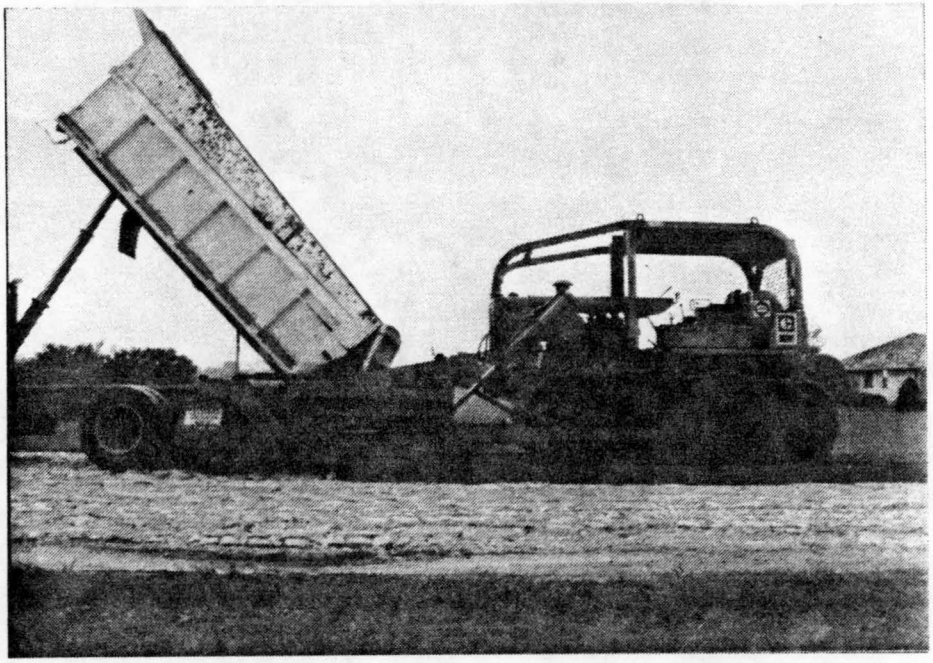


22a - Impact Foot of PB4 Pavement Breaker

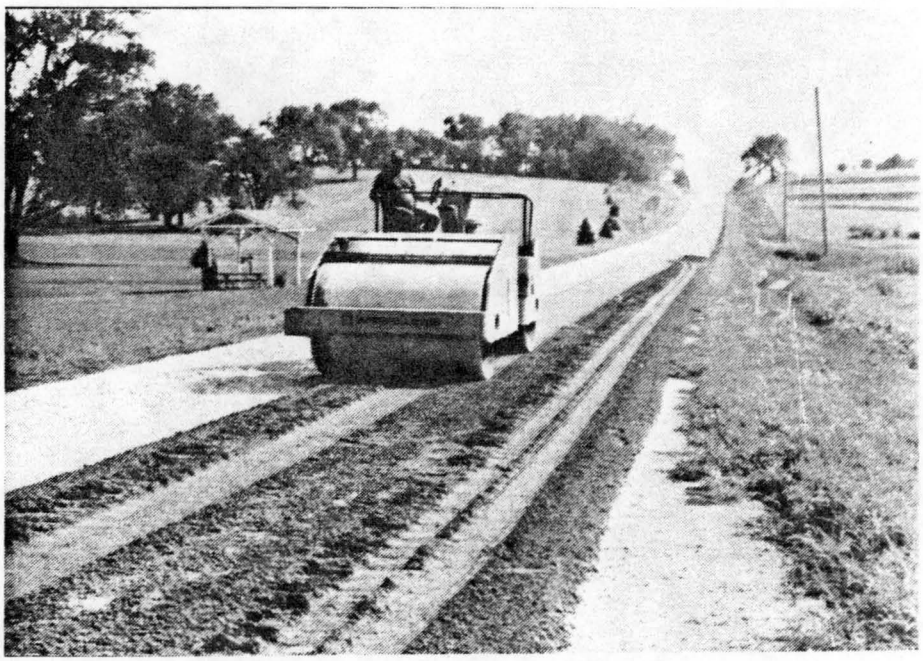


22b - Rubblizing in Process

22c - Rubblized Section of Pavement



23a - Application of Choke Stone Using "Jersey" Spreader



23b - Compaction of Choke Stone

24a - Subdrain Trenching